

parameters of interest (air-fuel ratio, carbon monoxide concentration, nitrogen oxide concentration, etc.) can be ascertained, as is known in the art.

As is also known in the art, in order for such air-fuel ratio sensors to function properly, the sensing element needs to be at a predetermined, elevated active temperature. Therefore, such air-fuel ratio sensors typically also have a heater to heat the sensor element to the active temperature. Heating the sensor can cause thermal shock and/or thermally induced stress, which can cause cracks to form in the sensor. Such cracks can cause the sensor to break (as a result of vibration to which it is subjected) or otherwise fail. The present invention overcomes such drawbacks in the prior art.

According to the present invention, an air-fuel ratio sensor includes, in addition to at least one solid electrolytic substrate layer and at least one insulating substrate layer, a boundary layer that is interposed between the solid electrolytic substrate layer and the insulating substrate layer. The boundary layer has an average sintered particle size that is larger than the average sintered particle size of the electrolytic substrate layer and that is larger than the average sintered particle size of the insulating substrate layer. As illustrated in FIGURES 5 and 6 of the Application, providing such a boundary layer (termed a "heterogeneous layer" in those FIGURES) significantly increases the sensor's bending strength (which increases the sensor's resistance to breaking) and the sensor's spalling strength (which increases the sensor's ability to withstand thermal shock).

In preferred embodiments, as reflected by the various claims, the porosity of the boundary layer is also larger than the porosity of the substrate layers, and the composition of the boundary layer is different from the composition of the electrolytic substrate layer and/or the insulating substrate layer.

Claims 1-2, 4, 6-7, 10-11 and 18-22 were rejected under 35 USC 103(a) as being unpatentable over Mase (USP 4,861,456) in view of Suzuki.

In essence, the Examiner's argument is that (a) Mase discloses a 'boundary layer' sandwiched between and more porous than the electrolytic and insulating layers; (b) Suzuki establishes equivalence of porosity and particle size; and (c) therefore, it would have been obvious to make the particles of the Mase 'boundary layer' larger than those of the electrolytic substrate layer and insulating substrate layer in order to achieve the larger porosity of the boundary layer. Applicants respectfully disagree.

Firstly, contrary to the Examiner's characterization, Mase does not disclose a 'boundary layer' between electrolytic and insulating layers. Mase teaches insulating layers 20, 34 between solid electrolytic layers 10, 8, and 28, respectively, and insulating layer 54 between heater 44 and electrolytic layer 28. Although the Examiner characterizes layer 50 (of the heater) as an insulation layer, it is not. It is an inner gastight ceramic layer (Column 8, lines 20-21). Thus, Mase teaches only porous insulating layers between ceramic layers; Mase does not teach providing a boundary layer between an insulating layer and an electrolytic layer, much less a boundary layer having an average sintered particle size larger than that of the electrolytic and insulating substrate layers.

Accordingly, the combination of Mase and Suzuki does not *ipso facto* yield the claimed invention. Therefore, Applicants respectfully submit that the rejection should be withdrawn.

Moreover, applicants previously provided the Examiner with factual evidence that average sintered particle size and porosity are not necessarily directly related, namely (1) the published article entitled "high PurityFine Alumina" which discloses a product (AKP-3000) having an average sintered particle size smaller than, but a porosity higher than another product (AKP-20), and (2) the article entitled "Development of Advanced Alumina 'Sumicorundum'" which explains that using particles having uniform or homogeneous size will yield a relatively higher density (lower porosity) product.

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Additionally, in further support of applicant's argument that the particle size of a raw material is not directly related to the particle size of the sintered body, it is requested that the following documents (copies attached hereto) be entered into the record:

1. JOURNAL OF THE CERAMIC SOCIETY OF JAPAN, Yogyo-Kyokai-shi, Vol. 94, 1986, which describes that the particle size of a starting material is smaller than the sintered particle size.
2. JOURNAL OF THE CERAMIC SOCIETY OF JAPAN (1998) which describes that the sintered particle size is not the same even if the particle size of a raw material is the same. The particle size of a starting material is smaller than the sintered particle size.

For all the reasons set forth above, it is respectfully submitted that the claimed invention is not anticipated by nor obvious from the record prior art.

In the event the Examiner remains of the view that the claims are properly rejected, the favor of a personal interview in advance of further action is respectfully requested.

Early and favorable Action are solicited.

Respectfully submitted,

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